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(54) **Belts for shoe presses**

(57) A long nip press belt (110) for a long nip press on a paper machine includes an endless base support substrate (112), a staple fiber batt (122) attached to at least one of the two sides of the endless base support substrate (112), and polymeric resin materials (128) totally impregnating the fiber/base composite structure (126,136) comprising the endless base support substrate and the staple fiber batt. A layer of polymeric resin material (130) is built up upon the fiber/base composite structure to a predetermined thickness on each side of the long nip press belt. Once the polymeric resin material is cured, at least the inside surface is ground to a desired smoothness without exposing any fiber on the ground surface.

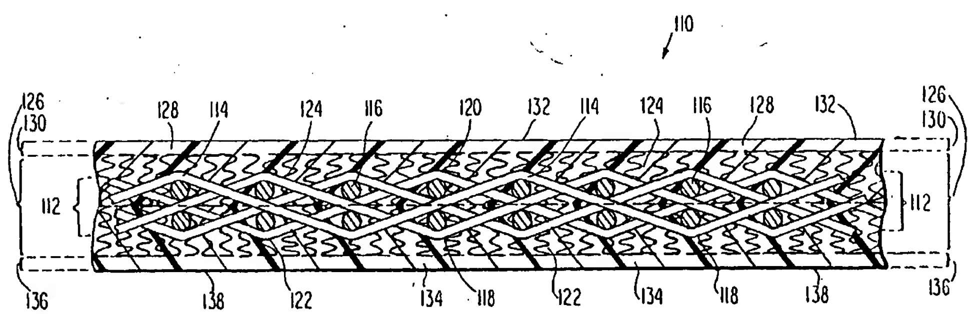

FIG. 5

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Description

Background of the Invention

1. Field of the Invention

[0001] The present invention relates to mechanisms for extracting water from a web of material, and more particularly from a cellulosic fibrous web being processed into a paper product on a papermaking machine. Specifically, the present invention is an impermeable belt designed for use on a long nip press on a papermaking machine.

2. Description of the Prior Art

[0002] During the papermaking process, a fibrous web is formed on a forming fabric by depositing a cellulosic fibrous slurry thereon. A large amount of water is drained from the slurry during this process, after which the newly formed fibrous web proceeds to a press section. The press section includes a series of press nips, in which the fibrous web is subjected to compressive forces designed to remove water therefrom. The fibrous web finally proceeds to a drying section which includes heated dryer drums around which the web is directed. The heated dryer drums reduce the water content of the web to a desirable level through evaporation, producing a paper sheet.

[0003] Rising energy costs have made it increasingly desirable to remove as much water as possible from the fibrous web prior to its entering the dryer section. The dryer drums are often heated from within by steam and related costs can be substantial especially when a large amount of water needs to be removed from the fibrous web.

[0004] Traditionally, press sections have included a series of nips formed by pairs of adjacent cylindrical press rolls. In recent years, the use of long nip press nips has been found to be advantageous over the use of nips formed by pairs of adjacent press rolls. This is so because the longer the time a cellulosic fibrous web can be subjected to pressure in the nip, the more water can be removed there, and, consequently, the less water will remain behind in the fibrous web for removal through evaporation in the dryer section.

[0005] The present invention relates to long nip presses of the shoe type. In this variety of long nip press, the nip is formed between a cylindrical press roll and an arcuate pressure shoe. The latter has a cylindrically concave surface having a radius of curvature close to that of the cylindrical press roll. When the roll and shoe are brought into close physical proximity to one another, a nip, which can be five to ten times longer in the machine direction than one between two press rolls, is formed. This increases the so-called dwell time of applied pressure on the fibrous web in the long nip. The result of this new long nip technology has been a dramatic increase in the dewatering of the fibrous web in the long nip when compared to that obtained with conventional nips on paper machines.

[0006] A long nip press of the shoe type requires a special belt, such as that shown in U.S. Patent No. 5,238,537. Such a belt must be provided with a smooth, impervious surface that rides, or slides, over the stationary shoe on a lubricating film of oil. The belt moves through the nip at roughly the same speed as the press fabric, thereby subjecting the press fabric to minimal amounts of rubbing against the surface of the belt.

[0007] Belts of the variety shown in U.S. Patent No. 5,238,537 are made by impregnating a woven base fabric, which takes the form of an endless loop, with a synthetic polymeric resin. Preferably, the resin forms a coating of some predetermined thickness at least on the inner surface of the belt, so that the yarns from which the base fabric is woven may be protected from direct contact with the arcuate pressure shoe component of the long nip press. It is specifically this coating which must have a smooth, impervious surface to slide readily over the lubricated shoe and to prevent any of the lubricating oil from penetrating the structure of the belt to contaminate the press fabric, or fabrics, and fibrous web.

[0008] The base fabric of the belt shown in U.S. Patent No. 5,238,537 may be woven from monofilament yarns in a single- or multi-layer weave, and is woven so as to be sufficiently open to allow the impregnating material to totally impregnate the weave. This eliminates the possibility of any voids forming in the final belt. Such voids may allow the lubrication used between the belt and shoe to pass through the belt and contaminate the press fabric or fabrics and fibrous web.

[0009] When the impregnating material is cured to a solid condition, it is bound to the base fabric by a mechanical interlock, wherein the cured impregnating material surrounds the yarns of the base fabric.

[0010] Depending on requirements, there is frequently a need to control the depth to which the impregnating material penetrates within the base fabric. This may be desirable either because only one side of the base fabric is to be coated, or because each side is to be coated in a separate operation.

[0011] Heretofore, filler or stuffer yarns have been included in the base fabrics for this purpose. Their use has been only partly successful; despite the inclusion of filler or stuffer yarns, some seepage of the impregnating material through the base fabric invariably occurs in a nonuniform manner. Where the base fabric is only to be coated on one side, this presents at least an aesthetic problem, as the uncoated side of the base fabric ultimately appears blotchy and nonuniform due to uneven penetration by the impregnating material.

[0012] Because the cured impregnating material is primarily bound to the base fabric by a mechanical interlock, the impregnating material must penetrate to a depth sufficient to ensure that it will to some extent interlock with the base fabric, and will not delaminate

readily therefrom. Where both sides of the base fabric are to be coated in separate operations, the impregnating material on each side must be sufficiently bound to prevent delamination. To ensure such an outcome, the impregnating material on the first side to be coated should penetrate uniformly to a depth enabling it to be mechanically bound to the base fabric, while leaving sufficient unimpregnated structure to enable impregnating material applied to the other side to be mechanically bound thereto. If the impregnating material has penetrated too deeply from the first side, that applied to the other side may have too few interlocking sites and may eventually delaminate.

[0013] One approach that has been proposed for overcoming this difficulty is to first coat one side of the base fabric with the impregnating material, and to allow that coating to at least partially cure. Then, after inverting (turning inside out) the base fabric, one applies a tie coat to the other side, followed by a coating of the impregnating material. The tie coat provides an additional chemical bond between the coatings on the two sides of the base fabric. The application of the tie coat, however, represents an extra process step and is difficult to control.

[0014] The present invention is an improved belt for a long nip press wherein both sides of a base fabric are coated with an impregnating material which penetrates into the base fabric an amount sufficient to ensure that the coating is unlikely to delaminate from either side.

Summary of the Invention

[0015] Accordingly, the long nip press belt of the present invention comprises a base support substrate which is in the form of an endless loop and has an outer side and an inner side. A first staple fiber batt is attached to either the inner side or the outer side of the base support substrate and extends at least partly therethrough, and a second staple fiber batt may be attached to the other side of the base support substrate and, if so, also extends at least partly therethrough. Together, the base support substrate and first and, possibly, second staple fiber batts constitute a fiber/base composite structure.

[0016] A first polymeric resin material impregnates the fiber/base composite structure to a uniform depth therewithin from the inner side of the base support substrate, and forms a layer over any staple fiber batt on the inner side. The first polymeric resin material has a ground, polished or buffed surface, whereby, upon grinding, polishing or buffing, none of the staple fiber batt is exposed on the ground, polished or buffed surface.

[0017] A second polymeric resin material impregnates the fiber/base composite structure from the outer side of the base support substrate to the first polymeric resin material, and forms a layer over any staple fiber batt on the outer side of the base support substrate. The second polymeric resin material may also have a ground, polished or buffed surface, whereby, upon grinding, polishing or buffing, none of the staple fiber batt is exposed on the ground, polished or buffed surface. The long nip press belt of the present invention is impermeable to oil and water.

[0018] The base support substrate may be any one of the structures used as bases for paper machine clothing, such as a woven, nonwoven, braided or knitted fabric, an extruded sheet of polymeric resin material, an extruded mesh fabric, or a spiral-link fabric. The base support substrate may also be assembled from a strip of one of these materials spirally wound in a plurality of turns, each turn being joined to those adjacent thereto by a continuous seam, the base support substrate thereby being endless in a longitudinal direction.

[0019] The base support substrate may also be a laminated structure comprising two or more base layers, each of which may be one of the structures described above. Where the base support substrate is laminated, one of the component base layers may be an on-machine-seamable fabric, so that the long nip press belt may be seamed into endless form during installation on a paper machine.

[0020] A staple fiber batt is attached to the base support substrate, for example, by needling or hydroentangling. The staple fiber batt is attached to at least one of the two sides of the base support substrate, extending at least partly therethrough. The attachment is carried out so as to leave a layer of staple fiber batt on the side or sides of the base support substrate to which the staple fiber batt is attached.

[0021] A polymeric resin material is applied to the inner side of the fiber/base composite structure, and allowed to impregnate the fiber/base composite structure to a substantially uniform depth. A layer of the polymeric resin material is also built up above the surface of the fiber/base composite structure to ensure its total coverage by the polymeric resin material. After curing, some of the polymeric resin material is removed by grinding and/or polishing to achieve a desired smoothness without exposing any of the fiber/base composite structure.

[0022] The outer side of the fiber/base composite structure is also coated with a polymeric resin material of the same or of a different type. The polymeric resin material is allowed to impregnate the remainder of the fiber/base composite structure. A layer of the polymeric resin material is also built up above the surface of the fiber/base composite structure to ensure its total coverage by the polymeric resin material. After curing, some of the polymeric resin material may be removed by grinding and/or polishing to achieve a desired smoothness without exposing any of the fiber/base composite structure.

[0023] The present long nip press belt, with its uniform fiber-reinforced polymeric resin matrix, provides a uniform pressure pulse in the nip to the paper web being dewatered, and has a longer life potential than long nip press belts currently in use. In this regard, it provides a

solution to some of the problems associated with the long nip press belts of the prior art.

[0024] The present invention will now be described in more complete detail with appropriate reference being made to the accompanying figures.

Brief Description of the Drawings

[0025]

Figure 1 is a side cross-sectional view of a long nip press;

Figure 2 is a perspective view of a belt of the present invention;

Figure 3 is a perspective view of an alternate embodiment of the belt;

Figure 4 is a perspective view of another embodiment of the belt;

Figure 5 is a cross-sectional view of a first embodiment of the long nip press belt of the present invention; and

Figure 6 is a cross-sectional view, taken in the machine direction, of a second embodiment of the long nip press belt.

Detailed Description of the Preferred Embodiments

[0026] One type of long nip press for dewatering a cellulosic fibrous web being processed into a paper product on a paper machine is shown in a side cross-sectional view in Figure 1. The press nip 10 is defined by a smooth cylindrical press roll 12 and an arcuate pressure shoe 14. The arcuate pressure shoe 14 has about the same radius of curvature as the cylindrical press roll 12. The distance between the cylindrical press roll 12 and the arcuate pressure shoe 14 may be adjusted by hydraulic means operatively attached to arcuate pressure shoe 14 to control the loading of the nip 10. Smooth cylindrical press roll 12 may be a controlled crown roll matched to the arcuate pressure shoe 14 to obtain a level cross-machine nip profile. Instead of being smooth, cylindrical press roll 12 may be vented by grooving, blind drilling or the like.

[0027] Long nip press belt 16 extends in a closed loop through nip 10, separating cylindrical press roll 12 from arcuate pressure shoe 14. A press fabric 18 and a cellulosic fibrous web 20 being processed into a paper sheet pass together through nip 10 as indicated by the arrows in Figure 1. Cellulosic fibrous web 20 is supported by press fabric 18 and comes into direct contact with smooth cylindrical press roll 12 in nip 10. Cellulosic fibrous web 20 and press fabric 18 proceed through the nip 10 as indicated by the arrows. Long nip press belt 16, also moving through press nip 10 as indicated by the arrows, that is, counter-clockwise as depicted in Figure 1, prevents press fabric 18 from directly sliding against arcuate pressure shoe 14, and slides thereover on a lubricating film of oil. Long nip press belt 16, accordingly, must be impermeable to oil, so that press fabric 18 and cellulosic fibrous web 20 will not be contaminated thereby.

[0028] Where cylindrical press roll 12 is vented by grooving, blind drilling or the like, a second press fabric, sandwiching cellulosic fibrous web 20 with press fabric 18, is required to prevent cellulosic fibrous web 20 from directly contacting cylindrical press roll 12.

[0029] The long nip press belt of the present invention is also useful on long nip presses having configurations other than that shown in Figure 1, such as long nip presses which include a long nip press belt having a long loop travelling in an endless path, entrained around and supported from within by interior support rolls. Further, it should be understood that two press fabrics, one on each side of cellulosic fibrous web 20, may be used on long nip presses of these and other configurations.

[0030] A perspective view of the long nip press belt 16 is provided in Figure 2. The belt 16 has an inner surface 28 and an outer surface 30. The inner surface 28 is ground, polished or buffed to provide it with desired surface characteristics; the outer surface 30 may be ground, polished or buffed for the same reason.

[0031] Figure 3 is a perspective view of an alternate embodiment of the belt 32. The belt 32 has an inner surface 34 and an outer surface 36. The outer surface 36 is provided with a plurality of grooves 38, for example, in the longitudinal direction around the belt 32 for the temporary storage of water pressed from cellulosic fibrous web 20 and press fabric 18 in press nip 10.

[0032] Alternatively, the outer surface of the belt may be provided with a plurality of blind holes arranged in some desired geometric pattern for the temporary storage of water. Figure 4 is a perspective view of such an alternate embodiment of the belt 40. The belt 40 has an inner surface 42 and an outer surface 44. The outer surface 44 is provided with a plurality of blind holes 46, so called because they do not extend completely through the belt 40.

[0033] The long nip press belt of the present invention comprises three principal elements: a base support substrate; batt fiber attached to the base support substrate, the base support substrate and batt fiber together constituting a fiber/batt composite structure; and a polymeric resin applied to the fiber/batt composite structure.

[0034] The base support substrate may be a woven, nonwoven, knitted or braided structure of yarns of the varieties used in the production of paper machine clothing, such as monofilament, plied monofilament and/or multifilament yarns extruded from polymeric resin materials. Resins from the families of polyamide, polyester, polyurethane, polyaramid and polyolefin resins may be used for this purpose.

[0035] The base support substrate may also be extruded from a polymeric resin material of the varieties mentioned above in the form of a sheet or membrane, which may subsequently be provided with holes or perforations. Alternatively, the base support substrate may

be composed of mesh fabrics, such as those shown in commonly assigned U.S. Patent No. 4,427,734 to Johnson, the teachings of which are incorporated herein by reference. The base support substrate may also be a spiral-link belt of the variety shown in many U.S. patents, such as U.S. Patent No. 4,567,077 to Gauthier, the teachings of which are incorporated herein by reference.

[0036] Further, the base support substrate may be produced by spirally winding a strip of woven, nonwoven, knitted, braided, extruded or mesh material according to the methods shown in commonly assigned U.S. Patent No. 5,360,656 to Rexfelt et al., the teachings of which are incorporated herein by reference. The base support substrate may accordingly comprise a spirally wound strip, wherein each spiral turn is joined to the next by a continuous seam making the base support substrate endless in a longitudinal direction.

[0037] Finally, the base support substrate may be a laminated structure comprising two or more base layers, each of which may be a structure of one of the preceding types.

[0038] Once the base support substrate has been manufactured, and takes the form of an endless loop, batt fiber is applied to at least one of its two sides. Conventionally, the batt fiber is attached to the base support substrate by needling (fiber locking). Alternatively, other methods, such as heat fusing, hydroentangling, melt fiber, or fusible fiber layers, could be used to attach the batt fiber. In heat fusing, standard batt fiber materials are applied to the base support substrate and attached thereto upon exposure to heating at a temperature above their melting point. In melt fiber methods, fibers of lower melting point are mixed or blended with standard batt fiber materials and the batt produced from the mixture or blend is applied to the base support substrate and attached thereto upon exposure to heating at a temperature above the melting point of the fibers of lower melting point but below the melting point of the standard batt fiber materials. In fusible fiber layer techniques, a batt of lower melting point fibers is sandwiched between batts of standard batt fiber materials. All are applied to the base support substrate and are attached thereto by needling and by exposure to heating at a temperature above the melting point of the lower melting point fibers but below the melting point of the standard batt fiber materials. The batt may be composed of fibers having denier in the range from 1 to 80.

[0039] A polymeric resin system, such as a polyurethane resin system, is then applied to a surface of the fiber/base composite structure and allowed to penetrate from that surface to a substantially uniform depth within the fiber/base composite structure. The substantially uniform depth may be to any point within the structure, including completely through the structure, as well as completely through any batt fiber attached to the other surface of the base support substrate. In such a case, the entire base support substrate and all batt fiber would be totally encapsulated within the polymeric resin material. The batt fiber attached to the base support substrate, in any event, allows the depth of penetration by the resin into the fiber/base composite structure to be more precisely controlled, and ensures that the depth will be substantially uniform. The size, weight and density of the batt fibers aid in controlling resin penetration. The other surface of the base substrate may also be coated separately. In either case, the resin material is applied to a thickness above the surface of the fiber/base composite structure so that in the grinding and/or polishing of the surface or surfaces of the resin coating, no part of the fiber/base composite structure will be exposed. The polymeric resin material may be a polyurethane composition, and, if so, is preferably a 100% solids composition thereof to avoid the formation of bubbles during the curing process through which the polymeric resin material subsequently proceeds.

[0040] The polymeric resin system may be applied by any one of several well-known techniques. In one such technique, known as the multiple thin pass (MTP) technique, a coating bar extending across the full width of the fiber/base composite structure is used to apply a uniformly thick layer of the polymeric resin material at once across the full width. Subsequent layers of resin can be applied to build up appropriate thickness. Subsequent resin layers can be of different formulation or hardness depending on requirements.

[0041] In another technique, known as the single pass spiral (SPS) technique, a narrow strip of resin is applied to an endless fiber/base composite structure in a continuous spiral manner. Subsequent layers of resin may be applied to one or both sides of the structure to build up a desired coating thickness.

[0042] A powder coating technique, in which a uniformly thick layer of polymeric resin material is applied to the fiber/base composite structure in powder form and subsequently fused by heating devices, such as infrared heating devices, may also be used as an alternative to the MTP and SPS techniques.

[0043] The preceding coating techniques may also be used in any combination with one another.

[0044] Once the desired amount of resin coating has been applied to both sides of the fiber/base composite structure, and the resin cured, the resin surfaces may be ground, polished or buffed with an abrasive to impart to the surface a smoothness of the degree required by the ultimate application for which the long nip press belt is intended without exposing any fibers or yarns of the fiber/base composite structure.

[0045] Figure 5 is a cross-sectional view of a first embodiment of the long nip press belt 110. Long nip press belt 110 again comprises a base support substrate 112 woven in a duplex pattern from warp yarns 114 and weft yarns 116. Assuming base support substrate 112 to be in is endless form, it has an inside 118 and an outside 120.

[0046] In this first embodiment of the long nip press

belt 110, a staple fiber batt 122 is attached to the inside 118 of the base support substrate 112 and a staple fiber batt 124 is attached to the outside 120 of the base support substrate 112, each extending at least partly therethrough. Together, the base support substrate 112 and staple fiber batts 122,124 constitute a fiber/base composite structure 126. It should be understood, however, that either staple fiber batt 122 or staple fiber batt 124 may be attached alone without the other.

[0047] A polymeric resin material 128 is then applied to the outside 120 of the fiber/base composite structure 126 and penetrates to a uniform depth therewithin. A layer 130 of polymeric resin material 128 is built up above staple fiber batt 124 on the outside 120 of the fiber/base composite structure 126. After the polymeric resin material 128 is cured, layer 130 may be ground, polished or buffed to provide it with desired surface characteristics and the long nip press belt 110 as a whole with a uniform thickness. The grinding, polishing or buffing of layer 130 does not expose any fiber or yarn of the fiber/base composite structure 126 on the surface 132 of layer 130, so that the long nip press belt 110 has a layer 130 of polymeric resin material 128 of desired thickness over the staple fiber batt 124. A plurality of grooves, perhaps in the longitudinal direction as shown in Figure 3, or a plurality of blind holes, as shown in Figure 4, or other surface features, may then be formed in layer 130 by cutting, scoring, graving, drilling or the like to provide temporary storage volume for water pressed from a fibrous web and press fabric in a press nip, again without exposing any fiber or yarn of the fiber/base composite structure 126 on the surface 132 of layer 130, so that the long nip press belt 110 has a layer of polymeric resin material 128 covering all of staple fiber batt 124.

[0048] A polymeric resin material 134, either the same as or different from polymeric resin material 128, is then applied to the inside 118 of the fiber/base composite structure 126, penetrates thereinto up to polymeric resin material 128, and totally impregnates the remainder of the fiber/base composite structure 126. It should be understood, however, that the inside 118 of the fiber/base composite structure 126 could be coated first before the outside 120. A layer 136 of polymeric resin material 134 is built up below staple fiber batt 122 on the inside 118 of the fiber/base composite structure 126. After the polymeric resin material 134 is cured, layer 136 is ground, polished or buffed to provide it with desired surface characteristics and the long nip press belt 110 as a whole with a uniform thickness. As before, the grinding, polishing or buffing of layer 136 does not expose any fiber or yarn of the fiber/base composite structure 126 on surface 138 of layer 136, so that the long nip press belt 110 has a layer 136 of polymeric resin material 134 of desired thickness over the staple fiber batt 122 on the inside 118 of the fiber/base composite structure 126.

[0049] A second embodiment of the long nip press belt 170 is shown in cross section in Figure 6. In this cross-sectional view, which is taken in the machine direction, the long nip press belt 170 may be seen to have a laminated structure as a base substrate which comprises a primary base layer 172.

[0050] The primary base layer 172 is woven from monofilament yarns in a two-layer, or duplex, weave. Machine-direction yarns 174, which are the weft yarns in the on-machine-seamable fabric used as primary base layer 172, form seaming loops 176 which are interdigitated to create a passage through which a pintle 178 is directed to join the primary base layer 172 into endless form. Cross-machine direction yarns 180, which are the warp yarns during the weaving of the primary base layer 172, are, like the machine-direction yarns 174, monofilament yarns.

[0051] Primary base layer 172 need not be an on-machine-seamable fabric, although this is preferred because it would permit the long nip press belt 170 to be joined into endless form during installation on a long nip press.

[0052] A secondary base layer 182 is attached to the inside of the primary base layer 172. That is to say, more specifically, secondary base layer 182 is attached to the inner surface of the endless loop formed by the primary base layer 172. It should be understood, however, that the secondary base layer 182 may alternatively be attached to the outside of the primary base layer 172. In other words, secondary base layer 182 may alternatively be attached to the outer surface of the endless loop formed by primary base layer 172.

[0053] Secondary base layer 182 is of a single-layer weave, such as a plain weave, and may be joined into endless form by a woven seam, may be woven endless, or may be on-machine-seamable. Secondary base layer 182 is woven from machine-direction yarns 184 and cross-machine direction yarns 186, both of which may be monofilament yarns.

[0054] Secondary base layer 182 is placed beneath primary base layer 172, and placed into endless form therewithin by a pin seam if it is an on-machine-seamable fabric. The primary base layer 172 and secondary base layer 182 are then attached to one another by needling a staple fiber batt 188 through the secondary base layer 182 and into the primary base layer 172, building up a layer of staple fiber batt 188 beneath secondary base layer 182. Staple fiber batt 188 extends at least partly through primary base layer 172. A staple fiber batt 189 is attached to the outside of the primary base layer 172 and extends at least partly therethrough. Primary base layer 172, secondary base layer 182, staple fiber batt 188 and staple fiber batt 189 together form a fiber/base composite structure 190. As before, it should be understood that either staple fiber batt 188 or staple fiber batt 189 may be used alone without the other.

[0055] At least one or several layers of polymeric resin material 192 are then applied to the staple fiber batt 188 beneath secondary base layer 182. The polymeric resin material 192 penetrates into staple fiber batt 188, through secondary base layer 182, to a uniform depth

within primary base layer 172. The polymeric resin material 192 is built up to a desired thickness under the staple fiber batt 188, forming a layer 194. Once the desired thickness is reached, the polymeric resin material 192 is cured, and, once cured, layer 194 is ground, polished or buffed without exposing any of the staple fiber batt 188 on the surface 196 of layer 194 to provide layer 194 with desired surface characteristics and the long nip press belt 170 as a whole with a uniform thickness. As before, the grinding, polishing or buffing of layer 194 does not expose any fiber or yarn of the fiber/base composite structure 190 on surface 196 of layer 194, so that the long nip press belt 170 has a layer 194 of polymeric resin material 192 of desired thickness over the staple fiber batt 188 on the inside of the fiber/base composite structure 190.

[0056] A polymeric resin material 198, either the same as or different from polymeric resin material 192, is then applied to the staple fiber batt 189 on the outside of the primary base layer 172, penetrates thereinto up to polymeric resin material 192, and totally impregnates the remainder of the fiber/base composite structure 190. It should again be understood, however, that the outside of the fiber/base composite structure 190 could be coated first before the inside. A layer 200 of polymeric resin material 198 is built up above staple fiber batt 189 on the outside of the fiber/base composite structure 190. After the polymeric resin material 198 is cured, layer 200 may be ground, polished or buffed to provide it with desired surface characteristics and the long nip press belt 170 as a whole with a uniform thickness. As before, the grinding and/or polishing of layer 200 does not expose any fiber or yarn of the fiber/base composite structure 190 on the surface 202 of layer 200, so that the long nip press belt 170 has a layer 200 of polymeric resin material 198 of desired thickness over the staple fiber batt 189 on the outside of the fiber/base composite structure 190.

[0057] Where the primary base layer 172 is an on-machine-seamable fabric, as represented in Figure 6, the penetration of the polyurethane resin 192 must be controlled so that the seaming loops 176 remain open, that is, free of the polymeric resin material 192. In this way, following the curing and grinding of the polymeric resin material 192, the pintle 178 may be removed, and the polymeric resin material 192 and secondary base layer 182 cut above, but without damaging, the seaming loops 176, to place the long nip press belt 170 into flat, unseamed form for shipment and subsequent installation on a long nip press. Installation proceeds by interdigitating the seaming loops 176, and by directing a pintle 178 through the passage defined by the interdigitated seaming loops 176. A resin paste may then be applied to the cut in the polymeric resin material 192 to close the cut and make the seam impermeable. The resin paste may then be cured and ground to blend in with the rest of the polymeric resin material 192.

[0058] The present long nip press belts present numerous advantages not found in the long nip press belts of the prior art.

[0059] The presence of a staple fiber batt on one or both surfaces of the base support substrate enables the long nip press belt manufacturer to control the depth that the resin penetrates into the belt. That is, the batt fiber helps to establish a uniform resin penetration to a depth anywhere from partly to completely through the fiber/base composite structure. Without the staple fiber batt, the penetration of the resin into the base substrate is quite non-uniform. Non-uniformities are unacceptable in a long nip press belt because they cause localized areas of high pressure in the nip. This, in turn, may lead to non-uniform sheet dewatering. Further, where belts are coated on both sides, non-uniform resin penetration can lead to localized areas of poor bonding and consequent resin delamination during use. The use of staple fiber batt to control the depth of resin penetration solves both of these problems.

[0060] Further, the staple fiber batt acts to tie the polymeric resin material to the base support substrate, and eliminates the need for a tie coat or inner layer, thereby preventing resin delamination therefrom because of the higher coating surface area presented by the staple fiber batt as compared to a base support substrate lacking a staple fiber batt.

[0061] The staple fiber batt also becomes part of a fiber-reinforced resin matrix, which eliminates interlayer delamination, that is, delamination of built-up resin layers from one another. As an additional advantage, a fiber-reinforced resin matrix is less vulnerable to stress cracking and crack propagation. Further, the entire belt may be thicker than has heretofore been possible, because the resin coating is reinforced with the staple fiber batt.

[0062] The staple fiber batt also gives the long nip press belt a greater compressibility in the Z-direction, and perhaps a greater elastic recovery, than the long nip press belts of the prior art.

[0063] Finally, the staple fiber batt permits a thicker and heavier long nip press belt to be manufactured than is practical with an unneedled base substrate, because the staple fiber batt reduces the hysteresis effects caused by repeated compression and relaxation of the long nip press belt.

[0064] The following are examples of the present invention, and should not be construed to limit those claimed below.

Example I

[0065] A base support substrate having a primary base layer and a secondary base layer was manufactured. The primary base layer was of a duplex weave having 0.35 mm MD (machine-direction) monofilament yarns and 0.40 mm CD (cross-machine-direction) monofilament yarns. The MD yarn density was 100 yarns/decimeter, and the CD yarn density was 157

yarns/decimeter, in this primary base layer.

[0066] The secondary base layer was of a single-layer weave having 0.25 mm MD monofilament yarns and 4-ply 0.20 mm CD monofilament yarns, that is, plied monofilament yarns having four 0.20 mm monofilament strands. As was the case with the embodiment shown in Figure 6, the secondary base layer was an endless loop nested within the endless loop formed by the primary base layer.

[0067] The base support substrate, comprising the primary and secondary base layers, had a mass of 855 grams/m^2.

[0068] Batt fiber of 11 dtex (10 denier) was applied and attached to the base support substrate by needling. The batt fiber was applied in a density of 1135 grams/m^2, 10% of which was applied to the primary base layer of the base support substrate, that is, to the outside of the endless loop formed by the base support substrate. The total mass per unit area of the fiber/base composite structure (base substrate and staple fiber batt) was 1990 grams/m^2.

[0069] This fiber/base composite structure was further processed to leave it with a density of 0.423 grams/cm^3 and a thickness of 0.467 cm.

[0070] A polyurethane resin coating having a viscosity of 6000 cps was applied via multiple passes to the secondary base layer of the fiber/base composite structure, that is, to the inside of the endless loop formed by the base support substrate. The resin layer was built up slightly above the surface fiber plane. The resin-impregnated fiber/base composite structure was exposed to heat to dry and cure the resin. Surface grinding was carried out to provide the required smoothness without exposing any surface batt fiber.

[0071] Examination of a cross section of the belt revealed that the resin had penetrated only to the surface of the secondary base layer, and that the resin "coating" was present in approximately 40% of the thickness of the belt. Without the presence of the batt fiber, the resin would have penetrated into and through the primary and secondary base layers of the base support substrate, for all intents and purposes encapsulating them.

[0072] A polyurethane resin coating could then be applied to the primary base layer of the fiber/base composite structure, that is, to the outside of the endless loop formed by the base support substrate, and allowed to penetrate through the primary and secondary base layers and to form a layer slightly above the surface fiber plane on the outside of the primary base layer. After the resin is cured, the outside surface could be ground without exposing any surface batt fiber.

Example II

[0073] The same fiber/base composite structure as in Example I was made and processed. A polyurethane resin coating having a viscosity of 9000 cps was used, again being applied via multiple passes to the secondary base layer of the fiber/base composite substrate. The resin layer was built up slightly above the surface fiber plane on the inside of the endless loop formed by the base support substrate. The resin-impregnated fiber/base composite structure was exposed to heat to dry and cure the resin. Surface grinding was carried out to provide the required smoothness without exposing any batt fiber.

[0074] Examination of a cross section of the belt revealed that the resin had penetrated into the batt fiber portion, but had not reached the secondary base layer. Again, without the presence of the batt fiber, the resin would have penetrated into and through the primary and secondary base layers of the base support substrate.

[0075] As in Example I, a polyurethane resin coating could then be applied to the primary base layer of the fiber/base composite structure, that is, to the outside of the endless loop formed by the base support substrate, and allowed to penetrate through the primary and secondary base layers and to form a layer slightly above the surface fiber plane on the outside of the primary base layer. After the resin is cured, the outside surface could be ground without exposing any surface batt fiber.

[0076] In general, the specifics of the construction of the fiber/base composite structure and the type of polymeric resin, and its properties including viscosity, used to coat the fiber/base composite structure, are within the control of the belt manufacturer. For example, if the fiber/base composite structure used in Examples I and II were modified either by increasing its density by reducing its initial thickness, or by changing the size of the batt fiber to a finer material, such as 3.3 dtex (3 denier), the resin system used in Example I would have penetrated a smaller, substantially uniform distance into the batt structure.

[0077] A series of experiments wherein the specifics of the construction of the fiber/base composite structure, the resin systems used and the coating processes could be varied would yield data sets that would enable one to predict the depth of penetration of the particular resin, processed in a particular manner, for a given fiber/base composite structure.

[0078] Modifications to the above would be obvious to those of ordinary skill in the art, but would not bring the invention so modified beyond the scope of the appended claims.

Claims

1. A long nip press belt for a long nip press on a paper machine, said long nip press belt comprising:

    a base support substrate, said base support substrate being in the form of an endless loop and having an outer side and an inner side;
    a first staple fiber batt attached to one of said inner and outer sides of said base support sub-

strate and extending at least partly therethrough, said base support substrate and said first staple fiber batt together constituting a fiber/batt composite structure;

a first polymeric resin material impregnating said fiber/base composite structure to a uniform depth therewithin from said inner side of said base support substrate, said first polymeric resin material forming a layer over any of said first staple fiber batt on said inner side of said base support substrate and having a ground surface, whereby, upon grinding, none of said first staple fiber batt is exposed on said ground surface; and

a second polymeric resin material impregnating said fiber/base composite structure from said outer side of said base support substrate to said first polymeric resin material, said second polymeric resin material forming a layer over any of said first staple fiber batt on said outer side of said base support substrate.

2. A long nip press belt as claimed in claim 1 wherein said second polymeric resin material has a ground surface, whereby, upon grinding, none of said first staple fiber batt is exposed on said ground surface.

3. A long nip press belt as claimed in claim 1 wherein said base support substrate is a fabric selected from the group consisting of woven, nonwoven, knitted and braided fabrics.

4. A long nip press belt as claimed in claim 1 wherein said base support substrate is an extruded sheet of a polymeric resin material.

5. A long nip press belt as claimed in claim 1 wherein said base support substrate is an extruded mesh fabric.

6. A long nip press belt as claimed in claim 1 wherein said base support substrate is a spiral-link fabric.

7. A long nip press belt as claimed in claim 1 wherein said base support substrate is a strip material spirally wound in a plurality of turns, each turn being joined to those adjacent thereto by a continuous seam, said base support substrate being endless in a longitudinal direction, said strip material being selected from the group consisting of woven fabrics, nonwoven fabrics, knitted fabrics, braided fabrics, extruded sheets of polymeric material and extruded mesh fabrics.

8. A long nip press belt as claimed in claim 1 wherein said base support substrate is an on-machine-seamable fabric.

9. A long nip press belt as claimed in claim 1 wherein said base support substrate is a laminated structure comprising at least two base layers.

10. A long nip press belt as claimed in claim 9 wherein said at least two layers are a primary base layer and a secondary base layer.

11. A long nip press belt as claimed in claim 10 wherein at least one of said primary base layer and said secondary base layer is a fabric selected from the group consisting of woven, nonwoven, knitted and braided fabrics.

12. A long nip press belt as claimed in claim 10 wherein at least one of said primary base layer and said secondary base layer is an extruded sheet of a polymeric resin material.

13. A long nip press belt as claimed in claim 10 wherein at least one of said primary base layer and said secondary base layer is an extruded mesh fabric.

14. A long nip press belt as claimed in claim 10 wherein at least one of said primary base layer and said secondary base layer is a spiral-link fabric.

15. A long nip press belt as claimed in claim 10 wherein at least one of said primary base layer and said secondary base layer is a strip material spirally wound in a plurality of turns, each strip being joined to those adjacent thereto by a continuous seam, said at least one of said primary base layer and secondary base layer being endless in a longitudinal direction, said strip material being selected from the group consisting of woven fabrics, nonwoven fabrics, knitted fabrics, braided fabrics, extruded sheets of polymeric material and extruded mesh fabrics.

16. A long nip press belt as claimed in claim 10 wherein at least one of said primary base layer and said secondary base layer is an on-machine-seamable fabric.

17. A long nip press belt as claimed in claim 1 wherein said first staple fiber batt is attached by needling.

18. A long nip press belt as claimed in claim 1 wherein said first staple fiber batt is attached by hydroentanglement.

19. A long nip press belt as claimed in claim 1 wherein said first staple fiber batt is attached by heat fusing.

20. A long nip press belt as claimed in claim 1 wherein said first staple fiber batt is attached by melt fiber.

21. A long nip press belt as claimed in claim 1 wherein

said first staple fiber batt is attached by fusible fiber layers.

22. A long nip press belt as claimed in claim 1 wherein said layer of said second polymeric resin material on said outer side of said base support substrate includes a plurality of grooves for the temporary storage of water pressed from a fibrous web and a press fabric in a press nip.

23. A long nip press belt as claimed in claim 1 wherein said layer of said second polymeric resin material on said outer side of said base support substrate includes a plurality of blind holes for the temporary storage of water pressed from a fibrous web and a press fabric in a press nip.

24. A long nip press belt as claimed in claim 1 further comprising a second staple fiber batt attached to the other of said inner and outer sides of said base support substrate and extending at least partly therethrough, said first polymeric resin material forming a layer over any of said second staple fiber batt on said inner side of said base support substrate, none of said second staple fiber batt being exposed on said ground surface of said first polymeric resin material, and said second polymeric resin material forming a layer over any of said second staple fiber batt on said outer side of said base support substrate.

25. A long nip press belt as claimed in claim 24 wherein said second staple fiber batt is attached by needling.

26. A long nip press belt as claimed in claim 24 wherein said second staple fiber batt is attached by hydroentanglement.

27. A long nip press belt as claimed in claim 24 wherein said second staple fiber batt is attached by heat fusing.

28. A long nip press belt as claimed in claim 24 wherein said second staple fiber batt is attached by melt fiber.

29. A long nip press belt as claimed in claim 24 wherein said second staple fiber batt is attached by fusible fiber layers.

30. A long nip press belt as claimed in claim 24 wherein said second polymeric resin material has a ground surface, whereby, upon grinding, none of said second staple fiber batt is exposed on said ground surface.

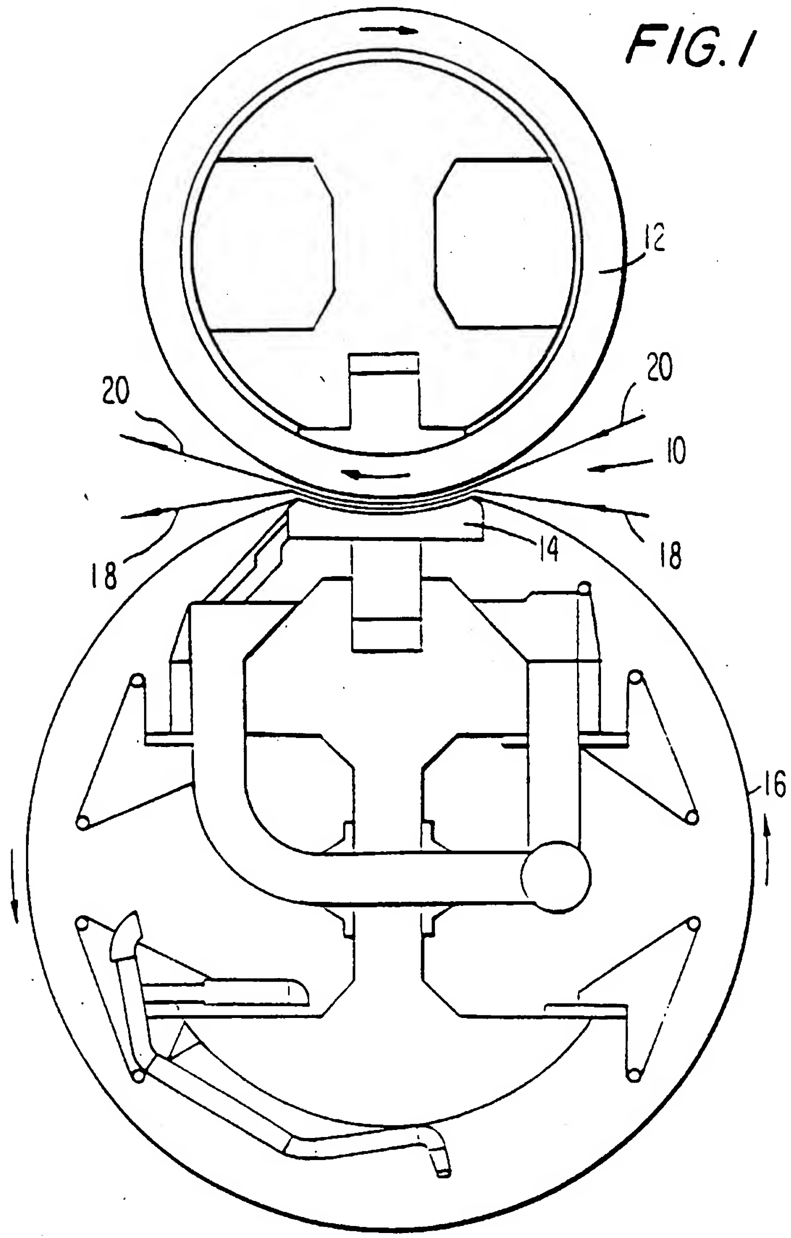

FIG. 1

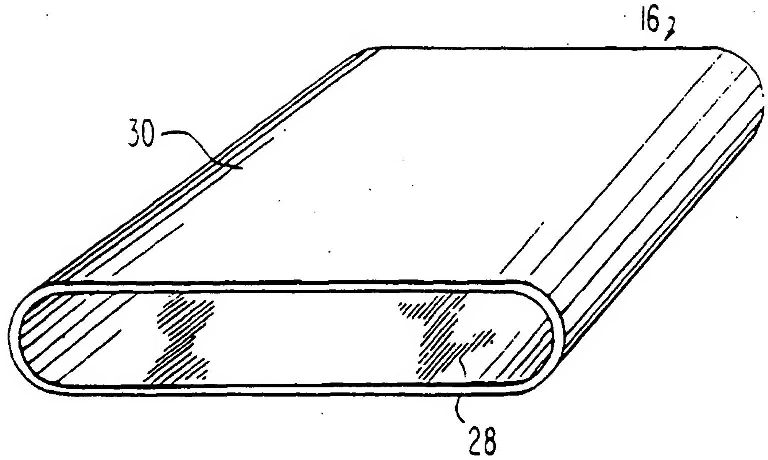

FIG. 2

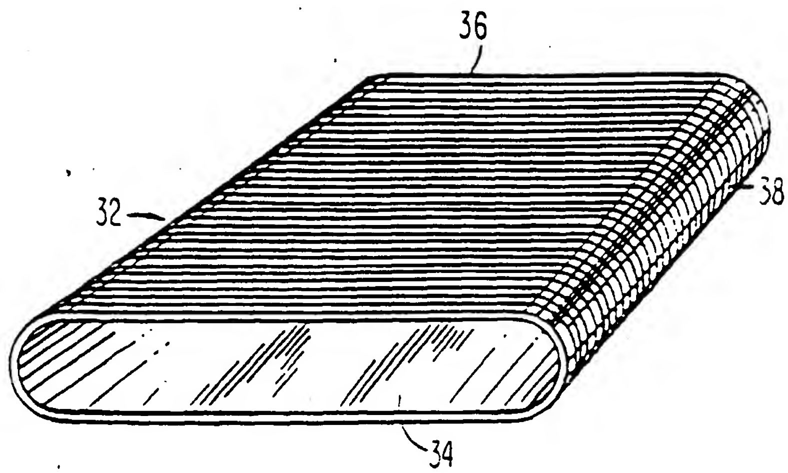

FIG. 3

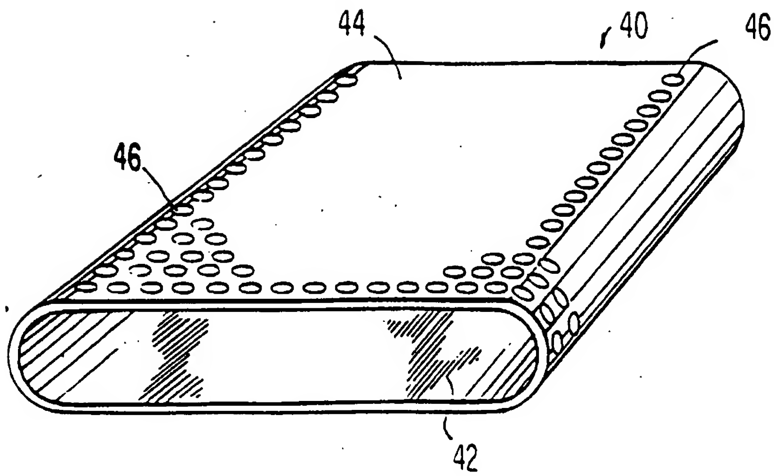

FIG. 4

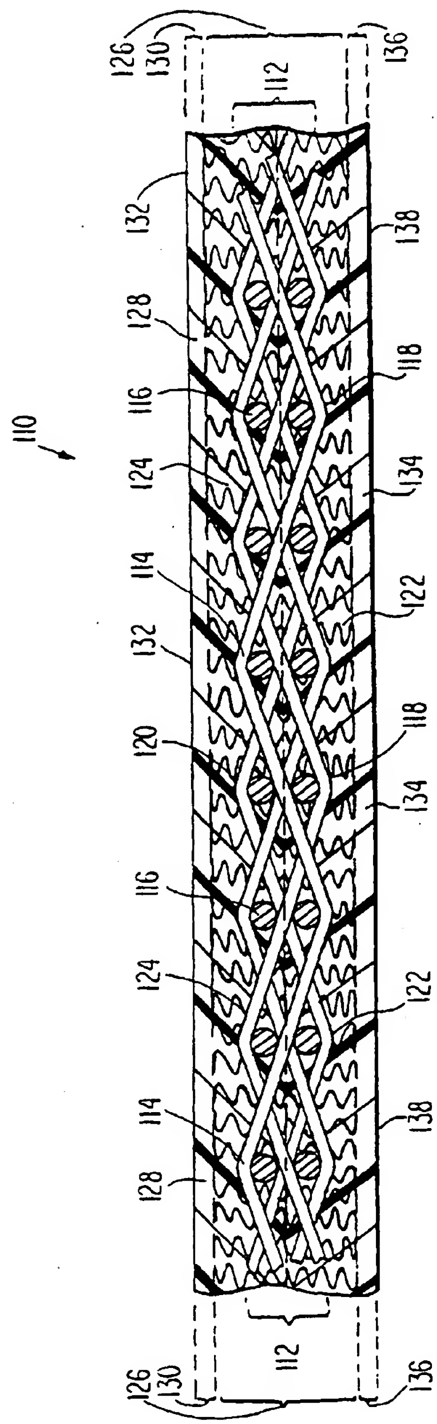
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FIG. 5

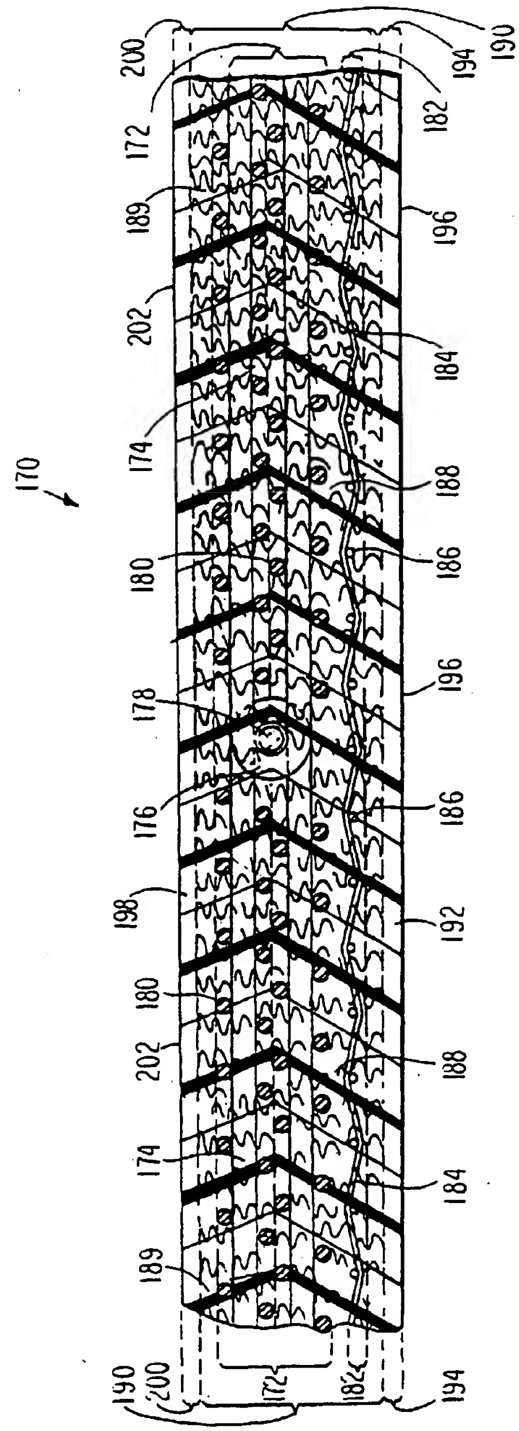
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FIG.6